11-427

TM 11-427

WAR DEPARTMENT TECHNICAL MANUAL

BAROMETERS

ML-102-B, ML-102-D, ML-102-E, ML-102-F, AND ML-316/TM

This reprint includes all changes in effect at the time of publication - Changes 2 and 3.

WAR DEPARTMENT • NOVEMBER 1944

D 101.11:

READEX FICHE best copy available

Change in force: C 2

TM 11–427
*C 2

BAROMETERS ML–102–B, ML–102–E, ML–102–F, ML–102–G, AND ML–316/TM

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *11 October 1963*

TM 11–427, 13 November 1944, is changed as follows:

(As changed by C 1, Jun 52) Title is changed as shown above.

Page 1. (As added by C 1, 17 Jun 52) Add the following note below the section heading:

Note. Barometer ML–102–G is similar to barometer ML–102–D. All information in this manual pertaining to barometer ML–102–D applies also to barometer ML–102–G unless otherwise indicated.

Add paragraph 1.1 after paragraph 1:

1.1 Scope

This manual describes Barometers ML–102–B, ML–102–E, ML–102–F, ML–102–G, and ML–316/TM, and covers their installation, operation, functioning of parts, and maintenance and repair. It also includes instructions for performing preventive maintenance checks and services.

1.2 Index of Publications

Refer to the latest issue of DA Pam 310–4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. DA Pam 310–4 is an index of current technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders available through publications supply channels. The index lists the individual parts (–10, –20, –35P, etc.) and the latest changes to and revisions of each equipment publication.

* This change supersedes C 1, 17 June 1952.

1.3 Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting by the individual user of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Technical Manual Parts Lists or Supply Manual 7, 8, or 9) will be used for reporting these improvement recommendations. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N.J., 07703. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc.).

Page 13, paragraph 13*b*(3). (As changed by C 1, 17 Jun 52) Make the following changes:

Subparagraph (*a*), line 2. Delete "red."

Subparagraph (*b*), line 3. Delete "red."

After subparagraph (5), add:

(6) For Barometer ML-102 G, additional accuracy may be obtained by applying the corrections determined from the scale calibration curve for each instrument, as illustrated in figure 6.1.

(*a*) Locate the indicated pressure on the horizontal scale of this graph. Note the point on the correction curve which is vertically above this pressure value.

(*b*) Read the value of the correction to be applied to that pressure from the point on the vertical scale of the graph corresponding to the point on the curve. If the correction is plus, it is to be added to the otherwise corrected pressure; if it is minus, the correction is to be subtracted.

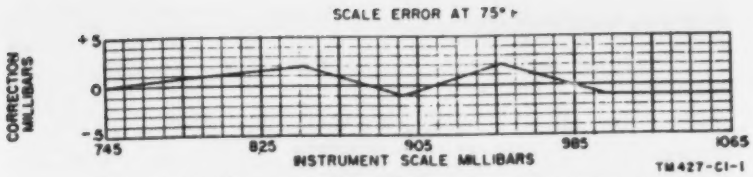

Figure 6.1. Barometer ML–102–G, scale calibration curve.

Page 18, paragraph 15*c*(4) (as changed by C 1, 17 Jun 52). After the last sentence, add: However, when using Barometer ML–102–G, an increase in accuracy may be obtained by applying a correction obtained from the scale calibration curve (fig. 6.1).

Page 22, figure 9 (as changed by C 1, 17 Jun 52). Delete the caption and substitute:

Barometer ML–102–D (or ML–316/TM or ML–102–G (serial numbers below 2033)), aneroid mechanism.

Paragraph 18*a*(1) (as changed by C 1, 17 Jun 52). Delete the first two sentences and substitute: The mechanism of Barometers ML–102–D, ML–102–G (serial numbers below 2033), and ML–316/TM is built on a triangular shaped aluminum base plate. A rectangular base plate is provided on ML–102–G, serial numbers higher than 2033 (fig. 9.1). The difference in range of the *three* instruments is achieved by changing the spring rate of the pressure sensitive cell.

Page 23, paragraph 18 (as changed by C 1, 17 Jun 52). Make the following changes:

Subparagraph *a*(2). After the second sentence, add: In Barometer ML–102-G, serial numbers higher than 2033 (fig. 9.1), the movement of the cell is transmitted to the gear sector lever by a push rod which has a flattened hinge section to allow for change in alignment. The gear sector lever is mounted on flexure pivots.

After subparagraph *b*(3), add:

(4) In Barometer ML–102–G, serial numbers higher than 2033 (fig. 9.1), the first stage is a simple lever magnification which is the ratio of the distance between the axis of the flexure pivot and the line of action of the push rod to the distance between the axis of the flexure pivot and the teeth of the gear sector.

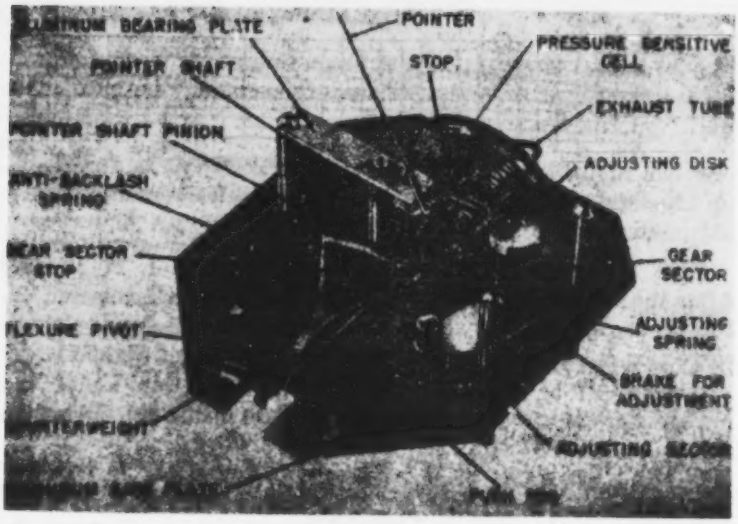

Figure 9.1. (as added by C 1, 17 Jun 52) *Barometer ML–102–G, serial numbers higher than 2033, aneroid mechanism.*

Page 24. Delete the *note* at the top of the page.

Delete paragraph 19 and substitute:

19. Scope of Maintenance

The maintenance duties assigned to the operator of Barometer ML–102–(*) and ML–316/TM are listed together with a reference to the paragraphs covering the specific maintenance functions. The tools and materials required are listed in paragraph 19.1.

a. Daily preventive maintenance checks and services (par. 19.4).

b. Cleaning (par. 19.5).

c. Quarterly preventive maintenance checks and services (par. 19.7).

d. Touchup painting (par. 19.8).

Add paragraphs 19.1 through 19.8 after paragraph 19:

19.1 Tools and Materials Required

The tools and materials required for operator maintenance are listed below.

a. Tool. Tool Equipment TE–33.

b. Materials.

(1) Cleaning compound (FSN 7930-395-9542).

(2) Cleaning cloth.

(3) Fine sandpaper.

(4) Beeswax, technical (FSN 9160-281-1475).

19.2 Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 19.4, 19.5, 19.7, and 19.8 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (pars. 19.4 and 19.7) outline functions to be performed at specific intervals. These checks and services are required to maintain Army equipment in serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining serviceability, the charts indicate what to check, how to check, and what the normal conditions are; the references column lists the paragraphs or manuals that contain additional information. If the defect cannot be remedied by the operator, higher echelon maintenance is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

19.3 Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily and quarterly.

a. Paragraph 19.4 specifies the checks and services that must be accomplished daily and under the conditions listed below.

(1) When the equipment is initially installed.

(2) When the equipment is reinstalled after removal for any reason.

(3) At least once each week if the equipment is maintained in standby condition.

b. Paragraph 19.7 specifies *additional* checks and services that must be performed on a quarterly basis.

19.4 Daily Preventive Maintenance Checks and Services Chart

Note. Refer to paragraphs 3, 5, 6, and 7 for details concerning the differences among the barometers.

Caution: **Handle barometer carefully. It is a precision instrument and can be easily damaged.**

Sequence No.	Item	Procedure	References
1	Carrying case	Inspect carrying case (fig. 1) for following:	
		a. Cleanliness (inside and outside).	*a.* Par. 19.5.
		b. Condition of body and straps (tears, cuts, etc.)	*b – d.* None.
		c. Missing hardware.	
		d. Mildew (fungus).	
2	Barometer.....	Inspect barometer for following:	
		a. Cleanliness of external surfaces.	*a.* Par. 19.5
		b. Rust and corrosion of metal surfaces.	*b.* Par. 19.8
		c. Loose or missing screws.....	*c – h.* None.
		d. Security of attachment of hanger or handle.	
		e. Cracked or damaged window (warpings).	
		f. Discoloration of meter dial (figs. 2 or 3).	
		Caution: **Do not remove case to inspect for dirt and moisture within barometer.**	
		g. Dirt and moisture within barometer. If dirt or moisture is found, refer barometer to higher echelon maintenance.	
		h. Damaged pointer. Tap instrument lightly to see that pointer is free and in equilibrium.	
3	Operation.....	During normal use of barometer be alert for any unusual performance or condition.	Sec. II.

19.5 Cleaning

Inspect the exteriors of the equipment. The exterior surfaces should be clean and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

Warning: **Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. *Do not* use near a flame.**

b. Remove grease, fungus, and ground-in dirt from the carrying case; use a cloth dampened (not wet) with cleaning compound.

c. Clean the inside of the carrying case with a brush.

Caution: **Do not press on the barometer window (plastic) when cleaning; the barometer may be damaged.**

d. Clean the barometer window; use a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water; mild soap may be used for more effective cleaning. Wipe dry with a clean dry cloth. Apply a thin coat of beeswax on the barometer window and rub well into window with a soft clean cloth. This will help remove light scratches and also prevent further scratching.

19.6 Quarterly Maintenance

Quarterly preventive maintenance checks and services on the equipment are required. Daily services constitute a part of the quarterly preventive maintenance checks and services (par. 19.7) and must be performed concurrently. All deficiencies or shortcomings will be recorded in accordance with the requirements of TM 38–750.

19.7 Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness.....	Inspect equipment for completeness (TM 11–6685–202–12P or SIG 7 & 8 ML–316/TM).	
2	Publications.....	*a.* Check to see that all pertinent publications are on hand, complete, and current. Requisition pertinent publications not on hand (App. and DA Pam 310–4). *b.* Check DA Pam 310–4 to determine whether all changes pertinent to the equipment are on hand.	

19.7 Quarterly Preventive Maintenance Checks and Services Chart—Con't.

Sequence No.	Item	Procedure	References
3	Modifications	Check DA Pam 310–4 to determine whether new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled (TM 38–750).	
4	Case	Inspect barometer case for condition of paint. If surfaces bear only a few slight scratches, retouch these with paint. If surfaces bear many scratches, repaint entire case.	Par. 19.8.
5	Barometer calibration.	***Caution:*** **Do not attempt to make corrective adjustments on barometer if readings are found to be erroneous.** Check accuracy of barometer readings by comparing its readings with those of a barometer (mercury or aneroid type) known to be accurate. If readings are not within approximately 0.02 or 0.03 inch of each other, turn in barometer for higher echelon maintenance.	
6	Chart	Check to see that correction chart (fig. 5 or 6) is on hand and serviceable. *Note.* Barometer ML-102-B and -F do not have correction chart.	Pars. 11 or 13.

19.8 Touchup Painting

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint (only on those parts or surfaces meant to be painted) on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9–213.

Page 30. Delete section V and substitute:

APPENDIX

REFERENCES

Following is a list of publications applicable to Barometer ML-102-(*) and Barometer ML-316/TM:

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
SIG 7 & 8 ML-316/TM	Organizational Maintenance Allowances and Field and Depot Maintenance Stockage Guide (Including Fixed Plant Maintenance List) for Barometer ML-316/TM.
TM 9-213	Painting Instructions for Field Use.
TM 11-6685-202-12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart for Barometers ML-102-B, ML-102-D, ML-102-E, ML-102-F, and ML-102-G.
TM 11-6685-202-35P	Field and Depot Maintenance Repair Parts and Special Tools List for Barometers ML-102-B, ML-102-D, ML-102-E, ML-102-F, and ML-102-G.
TM 38-750	The Army Equipment Record System and Procedures.

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution

Active Army:

USAES (5)	AAF (CONUS) (2)	
USAAMS (5)	USAERDL (2)	
USAAVNS (5)	Units org under fol TOE: (2 copies)	
USAADS (5)	1-127	
Erie A Dep (5)	1-137	11-597
Letterkenny A Dep (5)	1-207	39-51
Rossford A Dep (5)	7-45	39-52
Sacramento A Dep (10)	7-46	55-57
USMA (2)	8-137	55-58
USARSOUTHCOM Sig Agcy (2)	11-500 (AA-AC)	55-126
USA Elct Mat Spt Agcy (15)	11-587	55-127
APG (2)	11-592	55-128
Jefferson PG (2)		
USAEPG (2)		

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

Changes in force: C 2 and C 3

TM 11-427
C 3

CHANGE No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *20 December 1968*

BAROMETERS ML–102–B, ML–102–D, ML–102–E, ML–102–F AND ML–102–G, AND ML–316/TM

TM 11–427, 13 November 1944, is changed as follows:
Change the title of the manual as indicated above.
Page 1 (page 1 of C 2). Delete paragraphs 1.1, 1.2, and 1.3 and substitute:

1.1. Scope

This manual describes Barometers ML–102–B, ML–102–D, ML–102–E, ML–102–F, ML–102–G, and ML–316/TM, and covers their installation, operation, functioning of parts, maintenance, and repair. It also includes instructions for performing preventive maintenance checks and services and depot overhaul standards.

1.2. Indexes of Publications

a. DA Pam 310–4. Refer to the latest issue of DA Pam 310–4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310–7. Refer to DA Pam 310–7 to determine whether there are modification work orders pertaining to the equipment.

1.3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38–750.

b. Reports of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700–58 (Army), NAVSUP Publication 378 (Navy), AFR 71–4 (Air Force) and MCO P4610–5 (Marine Corps).

c. Discrepancy in Shipment Report (DISREP) (SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF361) as prescribed in AR 55–38 (Army), NAVSUP Pub 459 (Navy), AFM 75–34 (Air Force), and MCO P4610.19 (Marine Corps).

d. Reporting of Equipment Manual Improvements. The reporting of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U.S. Army Electronics

Command, ATTN: AMSEL-ME-NMP-AD, Fort Monmouth, N.J. 07703.

Page 7, paragraph 8. Delete subparagraphs *a* and *b* and substitute:

a. Location. Barometers ML-102-(*) and ML-316/TM are usually located and installed indoors in a semipermanent installation. Barometers should not be installed, for operational use, in fixed or mobile stations where air conditioning is used. Errors due to temperature and pressure variations will prevent the barometers from indicating the true values of the current atmospheric pressure to determine height above sea level or above ground and differences in elevation between two points.

b. Temperature. Determine accurate readings for correcting the barometer pressure reading as follows:

(1) Install the barometer where the temperatures will be constant. Normally an inside wall is preferable. When the barometer is used in an air-conditioned fixed or mobile station, remove the barometer and position it at an outside location at least 1½ hours before reading the atmospheric pressure.

(2) Do not expose the barometer to the direct rays of the sun.

(3) Keep the barometer away from sources of heat such as radiators or stoves.

(4) Do not place the barometer in a position where drafts from an outside door or window will affect the temperature readings.

Page 29. Add section IV.1 after section IV:

SECTION IV.1
DEPOT OVERHAUL STANDARDS

25. Applicability of Depot Overhaul Standards

The tests outlined in this section are designed to measure the performance of repaired or overhauled Barometers ML-102-(*) or ML-316/TM. The tests will be made on all repaired or overhauled barometers to insure that the equipment meets the required performance standards prior to return to use or stock.

26. Applicable References

a. Repair Standards. Applicable procedures of the depots performing these tests and the general standards required for repaired equipment form a part of the requirements for testing the barometers.

b. Technical Publications. The technical publications applicable to this equipment to be tested are TM 11-2421, TM 11-6685-202-12P, and TM 11-6685-202-35P.

c. Modification Work Orders. None.

27. Tools, Materials, and Test Equipment Required

The following tools and test equipment are required for depot overhaul.

a. Tools. Tool Kit, Radio Repair TK–115/G, FSN 5180–856–1578.

b. Test Equipment.

Equipment	Federal stock No.	Technical manual
Rotary vacuum pump (or equivalent).		TM 9–6685–202–15
Constant vacuum regulator (or equivalent).	6685–306–5604	TM 9–6685–202–15

28. Physical Tests, Preparation, and Inspection

a. Pressure Variation. The barometer will not be subjected to pressure variations in excess of 1 inch (33.864 millibars) of mercury for a period of 15 hours preceding each test.

b. Temperature Tests. The barometer will be maintained at the test temperature range (±5° F) for a period of at least 1 hour prior to test. During the testing period, the barometer will be maintained at the test temperature range within ±2° F.

c. Pressure Leakage. Pressure leakage in the test equipment will be adjusted, with the control valves, to the smallest minimum value. Adjustments will be made in the same direction as the pressure change being applied to the barometer under test. When pressure test values are increased or decreased, the pressure change should increase or decrease accordingly.

d. Pressure Changes. Barometers subjected to the pressure change test will be reduced from the current atmospheric pressure to the lowest test pressure value (745 millibars), increased to the upper test value (1,065 millibars), then reduced to the current atmospheric pressure. Test comparison data will be taken at decreasing and increasing pressure values.

e. Pressure-Temperature Calibration Values. For decreasing or increasing pressure changes, pressure calibration data will be taken, at intervals not to exceed 25 millibars. The recorded calibration data for each test cycle will be made within 1 millibar of the decreasing or increasing pressure change. Tests to determine values for pressure calibration at various temperature ranges will be taken at the same pressure value (0.3 millibar) for each temperature change.

f. Pressure Calibration at Timed Intervals. Before obtaining scale calibration test data, maintain a constant pressure on the barometer for at least 5 minutes; then proceed with the test for recording pressure change data at predetermined test points, not to exceed 50 millibars per minute.

g. Calibration Error Tolerance. Computation of the calibration error tolerance is the difference between the indication of Barometer ML–102–(*) and the corrected indication of the standard manometer from simultaneous readings. Indication of the test manometer will be determined to the nearest 0.05 millibar or thousandth of an inch and compared with the indication of Barometer ML–102–(*), which is estimated, as close as possible after lightly tapping, to the nearest 0.05 millibar or thousandth of an inch.

29. Test Procedures

a. Position Compensating Test.

(1) Take individual readings of the barometer indicator with the indicator dial placed in the vertical position and then in the horizontal position. The difference in the indicator readings between these two positions, when taken at the same elevation, should not exceed 0.3 millibar.

(2) Place the dial indicator in a vertical position; rotate the barometer slowly through 360° in any plane at the same elevation. The indicator reading should differ not more than 0.5 millibar between any two positions.

b. Drift Test. The barometer reading should be compared with a standard mercurial barometer at least twice a week for a period of 3 months. The barometer should not be subjected to pressure change other than normal changes of atmospheric pressure during this time. A progressive change exceeding 0.4 millibar during this interval is unacceptable.

c. Friction and Backlash.

(1) Handhold the barometer and carefully read and record the pressure reading. Without jarring or rotating the indicator dial, carefully lower the barometer approximately 3 feet; the pressure reading should increase. Repeat this test, raising the barometer approximately 3 feet; the barometer reading should decrease.

(2) Apply a pressure change of 0.3 millibar to the barometer; the pointer should indicate a change of at least 0.2 millibar without vibrating.

(3) Read the pressure indication; then move the pointer by hand to the left, approximately 15 millibars. Carefully release the pointer and allow it to return to its original position. Read the barometer without jarring or tapping. The displacement between readings should be less than 0.2 millibar. Repeat this test with the pointer moved to the right.

Note. Indication of uneven motion or hanging of the pointer at any point on the dial under test conditions of varying pressure, as specified in paragraph 29, is unsatisfactory.

d. Scale Calibration Test. The barometer should be maintained at a temperature between 70° and 85° F for this test. The pressure should be varied as described in paragraph 28, and comparative readings taken between Barometer ML–102–(*) and the standard manometer.

(1) The limits on the allowable calibration error are as follows:

Range of pressure	*Error at any point will not exceed*
1065 to 925	0.6 millibar.
926 to 850	1.0 millibar.
851 to 745	1.6 millibars.

(2) The error between adjacent test points should not exceed 0.6 millibar during comparative test pressure readings. Decreasing

and increasing pressure readings should not exceed 0.8 millibar at any point in the test range.

e. Repeatability Test at Room Temperatures. The tests specified in paragraph 28 should be repeated at the same test points specified and at a temperature not to exceed 5° F from that specified in the paragraph. The pressure values should not deviate by more than 0.4 millibar from any test point.

f. Accuracy Comparison Check. The average of the errors obtained in the tests specified in paragraph 28 and those obtained in the repeatability test (*e* above) should be computed. The average error should not exceed 0.3 of a millibar from the instrument correction curve furnished with each instrument.

g. Comparison Check for Temperature Error at 120° F. The average of errors obtained in the tests specified in paragraph 28 and those obtained in the repeatability test (*e* above) should be computed and should not exceed 0.8 millibar at any point throughout the temperature-pressure range. The errors found in the comparison check should not exceed 0.5 millibar from the barometer temperature calibration curve furnished with each instrument.

h. Comparison Check for Temperature Error at 30° F. The average of errors obtained in the tests specified in paragraph 28 and those obtained in the repeatability test (*e* above) should be computed and should not exceed 1.0 millibar at any point throughout the temperature-pressure range. The errors found on the comparison check should not exceed 0.5 millibar from the barometer temperature calibration curve furnished with each instrument.

i. Hysteresis Test. The barometer should not be subjected to pressure variations in excess of 1 inch (33.864 mb) of mercury for a period of 15 hours preceding the hysteresis test. Compare the barometric pressure reading with a standard barometer at the current atmospheric pressure. Place the barometer to be tested under a pressure of 745 millibars for at least 15 hours. The pressure during the test should vary not more than 50 millibars at room temperature. After the test period, allow the barometer to return to normal atmospheric pressure. Read and record the pressure reading. The error of the combined readings before and after the test should not exceed 1.2 millibars.

j. High Elevation Test. The barometer should not be subjected to pressure variations in excess of 1 inch (33.846 mb) of mercury for a period of 15 hours preceding the high elevation test. Compare the barometric pressure reading with a standard barometer at the current atmospheric pressure. Place the barometer under a pressure of 115 millibars for at least 4 hours. The pressure during the test should vary not more than 50 millibars at room temperature. After the test period, remove the test pressure to allow the barometer to return to normal atmospheric pressure. Read and record the barometer pressure reading.

The error before the test and 24 hours after the test should not exceed a difference of 0.3 millibar.

Page 30. Delete appendix (page 9 of C 1) and substitute new appendix:

APPENDIX
REFERENCES

Following is a list of publications applicable to Barometer ML–102–(*) and Barometer ML–316/TM:

DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310–7	U.S. Army Equipment Index of Modification Work Orders.
TM 9–213	Painting Instructions for Field Use.
TM 9–6685–202–15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Mercurial Altitude Test Barometer Type A–1 (Model F) (6685–537–9171).
TM 11–2421	Barometers ML–330/FM, ML–331/TM, ML–322/TM, ML–333/TM, and Mercurial Barometer ML–330A/FM.
TM 11–6685–202–12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart: Barometers ML–102–B, ML–102–D, ML–102–E, ML–102–F, and ML–102–G.
TM 11–6685–202–35P	Field and Depot Maintenance Repair Parts and Special Tools List: Barometers ML–102–B, ML–102–D, ML–102–E, ML–102–F, and ML–102–G.
TM 38–750	Army Equipment Record Procedures.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

USASA (2)
CNGB (1)
ACSC-E (2)
Dir of Trans (1)
CofEngrs (1)
TSG (1)
CofSptS (1)
USAARENBD (2)
USAAESWBD (5)
USARADBD (5)
USACDC Agency (1)
USAMC (5)
USCONARC (5)
ARADCOM (5)
ARADCOM Rgn (2)
OS Maj Comd (4)
USARYIS (5)
USARAL (5)
LOGCOMD (2)
USAMICOM (4)
USASTRACTCOM (4)
USAESC (70)
MDW (1)
Armies (2)
Corps (2)
USACOMZEUR (5)
Svc Colleges (2)
USAADS (2)
USAAMS (5)
USAARMS (2)
USAIS (2)
USAES (5)
USACMLCS (5)
USATC Armor (2)
USATC Inf (2)
USASTC (2)
WRAMC (1)
Army Pic Cen (2)
USATCFE (5)
USATC FA (5)
Instl (2) except
Fort Gordon (10)
Fort Huachuca (10)
WSMR (5)
Fort Carson (25)
Fort Knox (12)
APG (5)

Army Dep (2) except
LBAD (14)
SAAD (30)
TOAD (14)
LEAD (7)
SHAD (3)
NAAD (5)
SVAD (5)
CHAD (3)
ATAD (10)
RAAD (8)

GENDEPS (2)
SIG Sec GENDEPS (5)
Sig Dep (12)
Sig FLDMS (2)
AMS (1)
USAERDAA (2)
USAERDAW (13)
USACRREL (2)
MAAG (2)
USARMIS (2)
USARMA (2)
AAF (3)
Units organized under following TOE's (2 copies each):

1-55
1-56
1-59
1-100
1-101
1-127
1-128
1-137
1-207
1-257
1-258
6-100
6-175
6-300
6-517
6-525
6-527
7
8-137
10-206
11-57
11-97
11-98
11-117
11-127
11-157
11-155
11-158
11-500 (AA-AC) (RK, RL)
11-587
11-592
11-597
17
29-7
29-500
29-41
29-42
37
39-51
39-52
55-57
55-116
55-126
55-128
55-407
57
67

NG: None.

USAR: None.

For explanation of abbreviations used see AR 320-50.

WAR DEPARTMENT TECHNICAL MANUAL
TM 11-427

BAROMETERS ML-102-B, ML-102-D, ML-102-E, ML-102-F, AND ML-316/TM

WAR DEPARTMENT • NOVEMBER 1944

WASHINGTON: 1944

WAR DEPARTMENT,
WASHINGTON 25, D. C., 15 November 1944.

TM 11-427, Barometers ML-102-B, ML-102-D, ML-102-E, ML-102-F, and ML-316/TM, is published for the information and guidance of all concerned.

[AG 300.7 (19 Oct 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

Armies (5); SvC (5); Depts (5); Def C (2); Base C (5); T of Opn (5); D (2);* PC & S (2) (Cont) (1) (Oversea); PE (2): (2); Sig C Rep Shs (2).

Sig C Deps (2); Gen O/S SOS Deps (Sig Sec) (2); Sig C Labs (2); Sig C Rep Shs (2).

*Except Hosp Ctr Div, Gen Hosp, Med Dept Concentration Ctr of D 8; IBn 1 (5); IC 3, 11 (5);

IBn 1: T/O & E 1-627.

IC 3: T/O & E 3-26; 3-267.

IC 11: T/O 11-107; 11-127; 11-237; 11-287; 11-587; 11-592; 11-597.

For explanation of symbols, see FM 21-6.

DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.
2. Cut—Use axes, handaxes, machetes.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives—Use firearms, grenades, TNT.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT —1. Smash—case, mechanism, and carrying case.
2. Burn—wooden cases; technical manuals; records.
3. Bury or scatter—any or all of the above.

DESTROY EVERYTHING

CONTENTS

		Paragraph	Page
SECTION I.	DESCRIPTION		
	General	1	1
	Components	2	1
	Differences in barometers	3	2
	Characteristics	4	2
	Barometers ML-102-B, ML-102-E, and ML-102-F	5	3
	Barometers ML-102-D and ML-316/TM	6	3
	Carrying cases	7	6
SECTION II.	INSTALLATION AND OPERATION		
	Installation of barometer	8	7
	Aligning pointer	9	8
	Reading Barometers ML-102-B, ML-102-F and ML-102-F	10	8
	Correcting reading of Barometer ML-102-E for temperature	11	9
	Use of Barometer ML-102-E in determining approximate differences in elevation	12	10
	Reading Barometers ML-102-D and ML-316/TM	13	11
SECTION III.	FUNCTIONING OF PARTS		
	Principles of aneroid barometer	14	16
	Errors of aneroid barometer	15	16
	Barometer ML-102-B	16	19
	Barometers ML-102-E and ML-102-F	17	20
	Barometers ML-102-D and ML-316/TM	18	22
SECTION IV.	MAINTENANCE		
	Care of barometer	19	24
	Field inspection and maintenance	20	24
	Adjusting barometer	21	26
	Repairs to Barometers ML-102-B, ML-102-E and ML-102-F	22	27
	Repairs to Barometers ML-102-D and ML-316/TM	23	27
	Lubrication	24	29
SECTION V.	SUPPLEMENTARY DATA		
	Maintenance parts list for Barometers ML-102-B, ML-102-E and ML-102-F	25	30
	Maintenance parts list for Barometers ML-102-D and ML-316/TM	26	31

Figure 1. Barometers ML-102-(*) and ML-316/TM with carrying cases.

SECTION I

DESCRIPTION

1. GENERAL. a. Use. (1) The barometers described in this manual are aneroid-type barometers used to measure the pressure of the atmosphere. Aneroid, from the Greek *a* (no) + *neros* (wet) means "containing no liquid." The greatest advantage of the aneroid is its portability. It is widely used where the use of the mercury barometer would be inconvenient or impractical. It is also valuable in giving relative indications and in measuring pressure changes over a few hours.

(2) Apart from the measurement of pressure, there is a broad field for the use of the aneroid barometer in determining height above sea level or above the ground, and in determining differences in elevation between two points. When used to measure height, the aneroid is called an *altimeter*. Altimeters are widely used in aircraft and in surveying.

(3) The barometers covered in this book are designed for use in fixed or mobile stations and for transport by hand or in vehicles.

(4) Each barometer is an integral unit requiring no additional equipment to accomplish the purpose for which it is intended.

b. Reliability. The aneroid barometer is less accurate than the mercury barometer. It should not be depended upon for measurement of *absolute* values of pressure unless it is compared at intervals of 90 days or less with a mercurial barometer for which errors are known.

Note. The aneroid barometers covered by this technical manual are much more accurate than former types of aneroid.

c. Nomenclature. (1) Throughout this manual Barometer ML–102–(*) refers to Barometers ML–102–B, ML–102–D, ML–102–E, and ML–102–F, or any one of them.

(2) Any reference to "the barometer" includes Barometer ML–102–(*) or ML–316/TM. If Barometer ML–316/TM only is indicated, the complete nomenclature is used.

2. COMPONENTS. a. Barometers ML–102–B, ML–102–E, ML–102–F. (1) *Pressure measuring and indicating system.* (*a*) Pressure sensitive cells (five in Barometer ML–102–B; two in Barometers ML–102–E and ML–102–F).

(*b*) Lever system.

(*c*) Indicating pointer.

(2) *Metal case.* (*a*) Metal base.

(*b*) Dial.

(*c*) Plastic window and snap ring.

(3) Mounting frame assembly. (*a*) Metal frame in two sections.

(*b*) Screws, lockwashers, and nuts.

(*c*) Temperature correction chart and nomograph supplied for Barometer ML–102–E only.

(4) *Carrying case with strap.*

b. Barometers ML–102–D and ML–316/TM. (*a*) Pressure sensitive cell.
(*b*) Lever system.
(*c*) Pointer.
(2) *Case.* (*a*) Wooden base and lid.
(*b*) Dial.
(*c*) Dial cover.
(*d*) Temperature correction and conversion chart.
(3) *Carrying case with strap.*

3. DIFFERENCES IN BAROMETERS. a. Barometer ML–102–B (fig. 1). Externally, Barometer ML–102–B is identical to Barometer ML–102–F. Both are contained in black metal cases and leather carrying cases. The internal mechanism of Barometer ML–102–B, however, differs from all other models, for it has five pressure cells and a more complicated lever system (par. 16).

b. Barometer ML–102–E (fig. 1). The case of Barometer ML–102–E is of metal, painted dark green, with a crackle finish. It has a solid back provided with a metal rim which holds a nomograph and temperature correction chart, calibrated specifically for each instrument. This model has two pressure sensitive cells (for complete description see par. 17).

c. Barometer ML–102–F (fig. 1). The exterior of this model is identical to that of Barometer ML–102–B. The interior is identical to that of Barometer ML–102–E.

d. Barometer ML–102–D. This barometer differs both in appearance and construction from other Barometers ML–102–(*). Externally it is housed in a square wooden case; the internal mechanism contains only one pressure cell. It is of much lighter construction than Barometers ML–102–B, ML–102–E, and ML–102–F.

e. Barometer ML–316/TM. This model is identical to Barometer ML–102–D in appearance and construction, differing only in the range of pressure (par. 4b).

4. CHARACTERISTICS. a. Essential components of aneroid barometer. The aneroid barometers covered in this manual consist of the following parts:

(1) An almost completely evacuated metal cell (or cells) sensitive to changes in the atmospheric pressure.

(2) A system of levers and gears by which the motion of the cell is magnified and transmitted to a pointer. The cell and lever system is hereafter referred to as the aneroid mechanism.

(3) A dial on which the pointer indicates the changes or pressure.

b. Pressure range. (1) *Barometers ML–102–B, ML–102–E, and ML–102–F.* The range of pressure of these instruments is 1085 to 745 millibars and 31.5 to 22 inches. The dials are graduated in both millibars and inches.

(2) *Barometer ML–102–D.* The range of pressure of this barometer is 1065 to 745 millibars. The dial is graduated in millibars only.

(3) *Barometer ML–316/TM.* The range of pressure of this barometer is 1065 to 610 millibars. The dial is graduated in millibars only.

c. Dimensions and weight. The following tables gives the dimensions and weight of the barometers covered in this manual:

Barometer	Dimensions (in.)			Approx. weight (lb.)	Approx. weight including carrying case (lb.)
	Length	Width	Depth		
ML–102–B and ML–102–F	6¾	6¾	4	6	7½
ML–102–E	6¾	6¾	4	6	10½
ML–102–D and ML–316/TM ...	6¼	6¼	4	2½	4¼

5. BAROMETERS ML–102–B, ML–102–E, and ML–102–F (fig. 1). **a. Frame and case.** These three barometers are shock-mounted in metal frames. The case is secured to the schockmounts in the frame at the four corners with screws, washers, and nuts (fig. 10). The barometer case consists of a kettle-shaped brass housing over which is fitted a circular casting with four ears for mounting it to the frame. A plastic window in this casting, held in place by a snap ring, protects the dial. A slotted screw on the bottom side of the case enables the instrument to be adjusted without opening the case. A metal ring is provided at the top of the frame for hanging the barometer. The back of the case of Barometer ML–102–E has a metal rim which holds in place a nomograph and temperature correction chart.

b. Dial (fig. 2). The dials on the three instruments are identical. Each is 5¼ inches in diameter and has three scales. The outer scale is graduated in fiftieths (0.02) inches, with numerical designations for whole inches from 26 to 31, and smaller numbers for tenths of inches. The center scale is graduated in whole millibars from 1085 to 895 millibars. The innermost scale is graduated from 895 to 745 millibars. Every five millibars bears a numerical designation. In the center of the dial is a shaft bearing an aluminum pointer which is flattened vertically at the indicating end. Concentric with the scales and between the inch and millibar scales is a mirror ring, the purpose of which is to reflect the pointer and facilitate the reading of the scales (par. 10).

c. Aneroid mechanism (figs. 7 and 8). The aneroid mechanism of these barometers is built upon a casting which is mounted to a gear plate, held in place by brackets and screws. The principle of operation is the same in the three barometers, but the internal mechanism of Barometer ML–102–B differs considerably from that of Barometers ML–102–E and ML–102–F. For a complete description of functioning of parts of Barometer ML–102–B, see paragraph 16. For Barometers ML–102–E and ML–102–F, see paragraph 17.

6. BAROMETERS ML–102–D AND ML–316/TM (fig. 1). **a. Case.** These instruments have identical wooden cases, painted olive drab, with metal reinforcements at the outside corners. Means for hanging the barometer temporarily is provided by a sliding metal hanger set flush with the back of the case. (For preferred position of this barometer, see paragraph 8c (2).) The lid is fastened to the case by separable hinges and

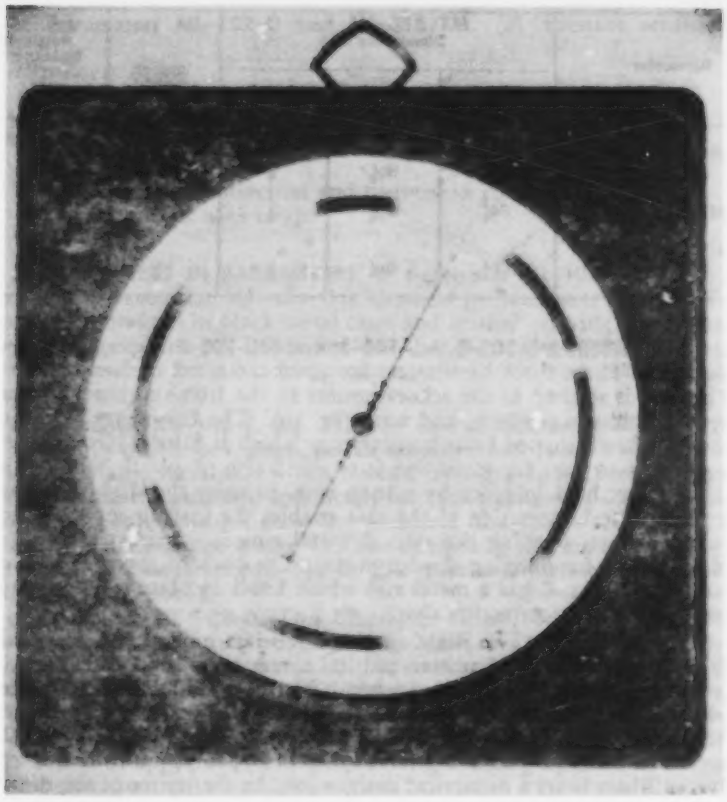

Figure 2. Barometer ML–102–F (or ML–102–B, or ML–102–E), close-up of dial.

is provided with a spring stop to prevent accidental removal. A temperature correction and conversion chart is mounted inside the lid of the case. A plastic window protects the dial. The pointer of the instrument is adjusted through a plugged opening in the window which permits access to a slot in the dial.

b. Dial (fig. 3). (1) The dial of these barometers is approximately 5¼ inches in diameter. It is graduated in half-millibar intervals and is calibrated for approximately two revolutions of the pointer. Since the graduations are not strictly linear, there is a separate scale for each revolution of the pointer. The two scales are concentric, one inside the other. A mirror ring, concentric with, and inside the two scales, reflects the pointer and eliminates parallax error when reading the scales (par. 9b).

(2) The dial of Barometer ML–102–D covers a pressure range of 1065 to 745 millibars.

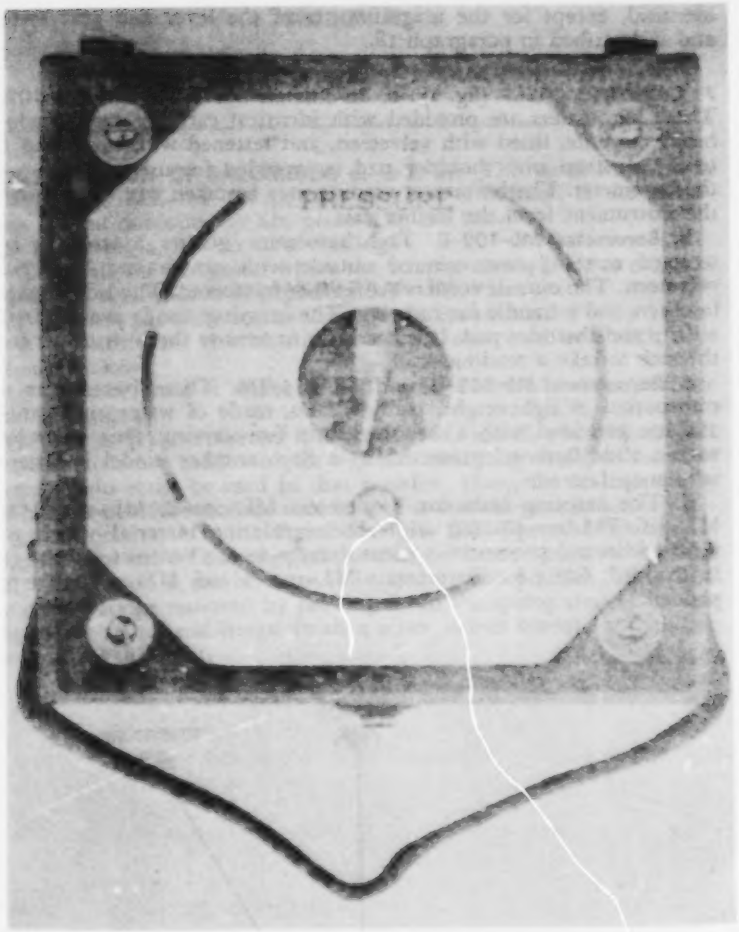

Figure 3. Barometer ML-102-D (or ML-316/TM), close-up of dial.

(3) The dial of Barometer ML-316/TM covers a pressure range of 1065 to 610 millibars.

(4) The pointer, made of three sections of fine aluminum tubing, flattened vertically at the indicating end, is clamped to the pointer shaft with a small setscrew. The barometer mechanism is mounted to the under side of the flat plate on which the dial graduations are marked. This plate has rubber mounts at each of the four corners to minimize vibration. Screws and washers, screwed into small corner blocks, hold the dial and the window in place.

c. Aneroid mechanism. The mechanism of the two barometers is

identical, except for the magnification of the lever and gear system, and is described in paragraph 18.

7. CARRYING CASES (fig. 1). **a. Barometers ML–102–B and ML–102–F.** These barometers are provided with identical carrying cases made of heavy cowhide, lined with velveteen, and fastened with four snap fasteners. A strap with shoulder pad is provided for use when carrying the barometer. The barometer reading may be taken without removing the instrument from the leather case.

b. Barometer ML–102–E. This barometer utilizes a strongly constructed carrying case, covered outside with canvas and lined with velveteen. The outside corners are leather-reinforced. The lid has metal fasteners and a handle for carrying. The carrying case is provided with a strap and shoulder pad. It is necessary to remove the instrument from the case to take a reading.

c. Barometers ML–102–D and ML–316/TM. These barometers are transported in lightweight, padded cases, made of waterproof canvas, and are provided with a webbing strap for carrying. One case closes with a slide fastener, protected by a flap; another model is fastened with snap fasteners.

d. The carrying cases for Barometers ML–102–E, ML–102–D and ML–316/TM are padded with shock-insulating material which provides additional protection against damage to the barometer if the case is dropped. Cases for Barometers ML–102–B and ML–102–F are unpadded.

SECTION II

INSTALLATION AND OPERATION

8. INSTALLATION OF BAROMETER. a. Location. The usual installation of Barometer ML–102–(*) or ML–316/TM is indoors. If the instrument is used outdoors, do not place it in the sun.

b. Temperature. For accurate readings:

(1) Install the barometer where the temperature will be as constant as possible. An inside wall is preferable.

(2) Do not allow the sun to shine on the instrument.

(3) Do not place the instrument near a source of heat such as a radiator or stove.

(4) Do not place it where it will be in a draft from an outside door or window.

c. Position. (1) *Barometers ML–102–B, ML–102–E, and ML–102–F.* These models are calibrated for vertical mounting and for most accurate results must be used in that position. Hang the instrument by the hanger provided and be sure it is in a vertical position.

(2) *Barometers ML–102–D and ML–316/TM.* These barometers are calibrated for use in a horizontal position, and more accurate readings will be obtained if the instrument is used in this position. If desired, the cover may be removed by pressing in on the spring stop at the left side of the right-hand hinge (with a screw driver blade), and sliding the cover to the right.

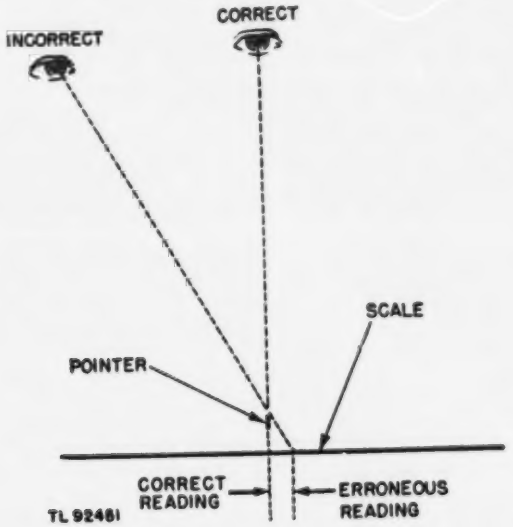

Figure 4. Illustration of parallax.

9. ALIGNING POINTER. a. Tap the instrument lightly to see that the pointer is free and in equilibrium. Have the dial lighted so that the image of the pointer is clearly visible in the mirror ring between the scales.

b. For a correct reading of the aneroid, when it is vertical, the eye must be on a level with the pointer. Never stand on tiptoe or look down at the dial of a barometer that is hanging on the wall. When the instrument is read with the dial in a horizontal position, have the eye directly above the pointer. To read the instrument correctly, have the eye in a direct line so that the image of the pointer in the mirror ring is obscured by the pointer itself (fig. 4). This is important in reading the aneroid since the pointer is approximately 3/32 inch above the dial and unless it is aligned so that it completely covers the image, parallax occurs and an erroneous reading results. In reading an aneroid barometer, parallax is the apparent displacement of the pointer with reference to the dial graduations when the pointer is viewed from the side rather than from directly above. This effect can readily be seen by moving the head to either side of the correct position and noticing the difference in the apparent indication of the pointer.

10. READING BAROMETERS ML–102–B, ML–102–E, AND ML–102–F.

Note. 1. If the barometer is transported by air, or there is a *rapid* change of pressure of 100 millibars or more, wait at least 24 hours before taking a reading in order to reduce hysteresis errors (par. 15a).

2. If the temperature of the instrument is changed suddenly by an amount exceeding 10° F., wait 1½ hours before taking a reading.

3. These barometers may be read in inches or millibars.

4. Tap the instrument lightly with the fingers before reading, to reduce residual friction in the linkage system.

a. Inch scale. (1) The outside scale is the inch scale. The inch scale may be used over a pressure range corresponding to 31.5 to 22 inches of mercury. The pointer makes more than one revolution of the dial in covering this range. A pressure of 25 inches and less is not marked on the dial. After the pointer has made one complete revolution, pressure values are obtained by subtracting six inches from the indicated value. Thus, on the second revolution 31 inches represents 25 inches of pressure, 30 inches represents 24 inches, 29 inches represents 23 inches, and 28 inches represents 22 inches of pressure. The observer must know the approximate elevation of the station in order to know which inch reading to use.

(2) The inch scale is graduated in 0.02 inch intervals. Integral inches and tenth inches are numbered. With practice, it is possible to make an estimated reading of the barometer to the nearest thousandth of an inch. Even with care, however, this estimated reading probably will be in error by as much as 0.003 inch.

(3) In figure 2 the inch reading is 29.9, plus 0.06 (since the pointer is beyond three graduations, each of which represents 0.02) ; the pointer is also past the center of the next division which increases the reading by an additional 0.01. Since it is slightly past the center, the reading is increased by an additional 0.002 or 0.003. Thus the approximated reading is 29.972 or 29.973 inches.

(4) Assuming that the pointer has made one revolution and is registering on the inner scale, the reading is 23.972 or 23.973 inches.

b. Millibar scale. (1) The center and inner scales measure the pres-

sure in whole millibars. While the range of the millibar scale is from 1085 to 745 millibars, these barometers are calibrated only to 1066.7 millibars (or 31.5 inches). This does not mean that higher pressure readings will be inaccurate, but only that the accuracy has not been checked above 1066.7 millibars.

(2) In covering the range of the millibar scale, the pointer makes almost two revolutions of the dial. Unlike the inch scale, the same scale is not used on the second revolution of the pointer. Pressures between 1085 and 895 millibars are read on the center scale, while pressures between 895 and 745 millibars are read on the inside scale.

(3) The millibar scales are graduated in whole millibars and estimated readings may be made to a tenth of a millibar.

(4) In figure 2 the reading on the outer scale is 1015.0 millibars. The reading on the inner scale is 811.8 millibars.

c. Station pressure. (1) The pressure, as read on the dial of Barometer ML–102–B or ML–102–F is the *station pressure*.

(2) The pressure, as read on the dial of Barometer ML-102-E must be corrected for temperature (see par. 11 below) before the station pressure is obtained.

11. CORRECTING READING OF BAROMETER ML–102–E FOR TEMPERATURE.

Note. Barometer ML–102–E must have a temperature correction applied to each reading. Barometers ML–102–B and ML–102–F are equally affected by temperature but temperature correction charts were not required, hence pressure data obtained from these two barometers generally will not be as accurate as that obtained from Barometers ML–102–E, ML–102–D and ML–316/TM.

a. Chart. The effect of temperature upon the indicated reading of Barometer ML–102–E has been determined by actual test for each instrument and the corrections are shown in the form of curves on the temperature calibration chart fastened to the back of each instrument (fig. 5). These curves also include a small residual error for each instrument (par. 15c (2)).

b. Method. (1) Three temperature curves are given on the graph: one for a temperature of 80° F., another for 40° F., and a third for 0° F. These curves are plotted on a grid on which the pressure is shown on the horizontal scale and the corrections on the vertical scale.

(2) To compute the temperature correction, determine the temperature to which the barometer has been exposed and locate the temperature curve nearest to that temperature.

(3) Find the indicated pressure on the horizontal scale. Move vertically until the pressure value meets the correction curve. From the point on the correction curve move horizontally to the left until the correction scale is encountered. If the pressure reading does not meet the temperature correction curve on a horizontal line, it will be necessary to estimate between the two tabulated correction values. Determine the correction at that point, noting whether it is plus or minus.

(4) Add or subtract this sum to the observed pressure reading.

Caution: If the temperature is changed very suddenly, wait at least 1½ hours before making a reading.

c. Interpolated correction. (1) When the temperature falls between the values for which correction curves are given, the corrections must be determined for both curves and the true correction by interpolation.

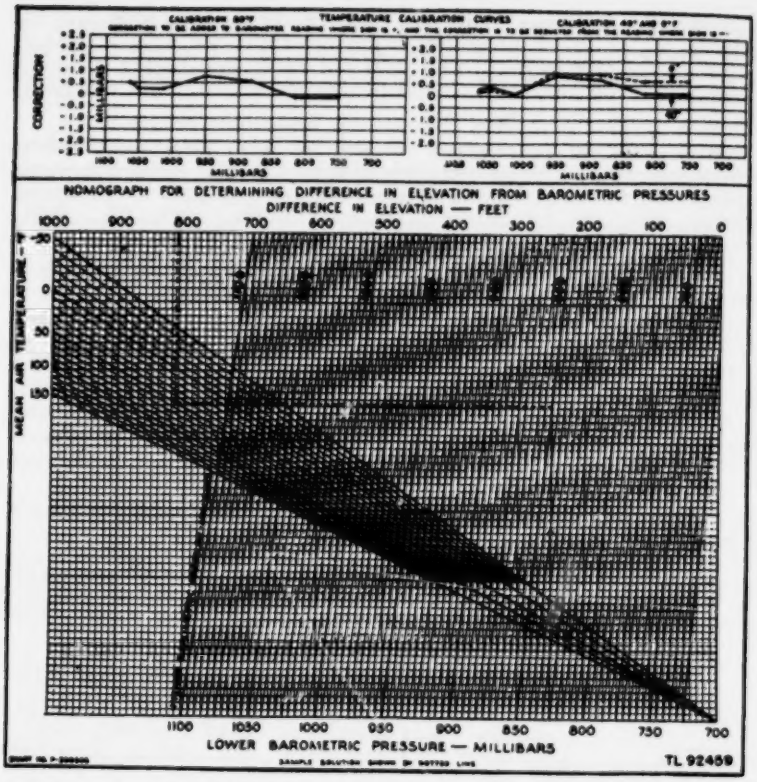
TEMPERATURE CALIBRATION CURVES
CORRECTION
MILLIBARS
NOMOGRAPH FOR DETERMINING DIFFERENCE IN ELEVATION FROM BAROMETRIC PRESSURES
DIFFERENCE IN ELEVATION — FEET
1000 900 800 700 600 500 400 300 200 100 0
MEAN AIR TEMPERATURE — °F
-30 0 50 100 150
1100 1050 1000 950 900 850 800 750 700
LOWER BAROMETRIC PRESSURE — MILLIBARS
TL 92459

Figure 5. Barometer ML–102–E, temperature correction curves and nomograph.

(2) Example: Assume that the indicated pressure is 810 millibars and the temperature 20° F. The temperature correction at 40° F. is 0.2 mb. The temperature correction at 0° F. is 0.7 mb. Interpolating between these two values, the true correction would be 0.45 mb. Since the barometer is read to the nearest tenth of a millibar, the correction to be used is 0.4 mb, making the corrected pressure 810.4 mb.

d. Correction in inches. Temperature corrections are given only in millibars. Corrections apply to both scales, however. In order to obtain the corresponding corrections in inches, multiply the millibar correction by 0.02954.

12. USE OF BAROMETER ML–102–E IN DETERMINING APPROXIMATE DIFFERENCES IN ELEVATION. a. Method. Barometer ML–102–E may be used either alone or with another precision barometer to determine the difference in elevation between two points by comparing the difference in pressure. Since humidity is a factor to be considered, the use of a thermometer or a psychrometer is required. This method also requires the use of a nomograph which is attached to the back of the

barometer case, or Smithsonion Meteorological Tables 51 and 52, Fifth Revised Edition. The procedure given in b and c below illustrates the use of two barometers. The procedure given in paragraph 13d illustrates the method when one barometer is employed. Either method may be used with satisfactory results.

b. Procedure. (1) Leave one barometer at a given location. Read the barometer and the thermometer at regular intervals and record the time, pressure, and temperature.

(2) Take the second barometer to the other location. Read it and record the time of the readings, pressure and temperature.

(3) Determine the average temperature between the two locations.

(4) If readings were not taken at both stations at the same time, interpolate to find the pressure value at each station at the same time as follows:

	9:00 AM	9:05 AM	9:15 AM
Fixed Barometer	849 mb	(850 mb)	852 mb
Mouile Barometer		825 mb	

(The interpolated pressure value, 850 millibars (mb), is shown in parenthesis. Assume that the mean air temperature between the two locations is 50° F.)

(5) With simultaneous pressure readings of 825 and 850 millibars at two different points and a mean temperature of 50° F., it is possible to obtain the difference in elevation by the use of the nomograph.

c. Use of nomograph (fig. 5). The nomograph of Barometer ML-102-E is marked on graph paper. Pressure values, in millibars, are represented by slanting vertical lines. Mean air temperature is represented by diagonal lines running from the lower right-hand corner to the top left side of the graph. To read the sample solution marked by dotted lines on the graph, proceed as follows:

(1) Locate the lower pressure value (825 mb) on the bottom scale.

(2) Move vertically upward until you intersect the slanting vertical line which corresponds to the higher pressure (850 mb).

Note. The use of a straightedge will help in using the nomograph.

(3) At the point of intersection, move horizontally until you intersect the diagonal line which corresponds to the mean air temperature (50° F.).

(4) At the point of intersection, move vertically upward to the top scale, and on this read the approximate difference in elevation between the two points. This is about 813 feet.

(5) Thus there is a difference of 813 feet between the two elevations. This corresponds to a difference of 25 millibars in pressure at 50° F., mean air temperature, *under these particular pressure conditions.*

13. READING BAROMETERS ML-102-D AND ML-316/TM.

Note. 1. If the barometer is transported by air, or if there is a rapid change of pressure of 100 millibars or more, wait at least 24 hours before taking a reading in order to reduce hysteresis errors (par. 15a).

2. If the temperature of the instrument is changed suddenly by an amount exceeding 10° F., wait 1½ hours before taking a reading.

a. General. (1) The dial of these barometers is graduated in half-millibar intervals and is calibrated for approximately two revolutions of the pointer.

(2) Barometer ML–102–D covers a range from 1065 to 745 millibars on two scales. Since each dial is individually calibrated to its respective pressure sensitive cell, the crossover point from the outer to the inner scale is between 880 and 920 millibars.

(3) Barometer ML–316/TM covers a range from 1065 to 610 millibars on two scales. The crossover point from outer to the inner scale occurs between 825 and 855 millibars.

(4) In reading the scales, estimate the reading to the nearest tenth millibar.

(5) In figure 3 the reading of the barometer is 1004.8 millibars on the outer scale. Assuming that the pointer has made one revolution of the dial, the reading is 839.4 millibars.

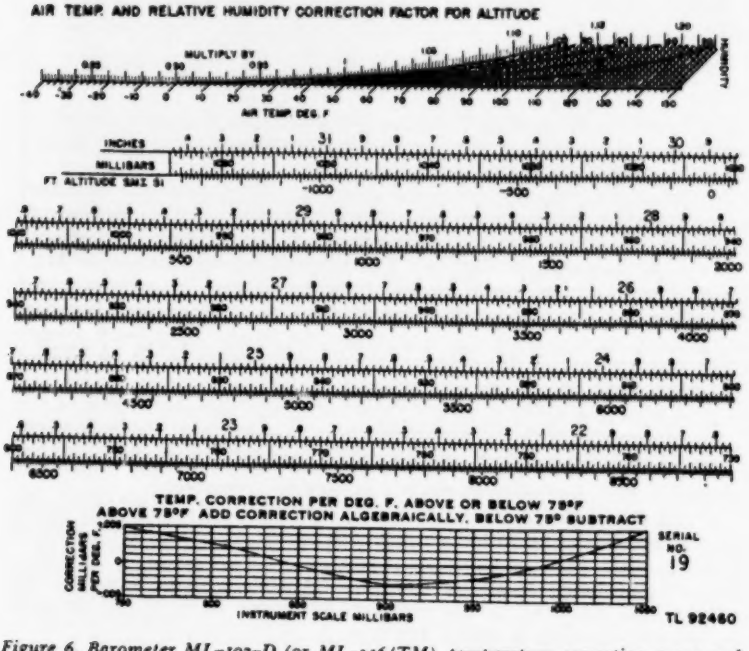
AIR TEMP. AND RELATIVE HUMIDITY CORRECTION FACTOR FOR ALTITUDE
MULTIPLY BY
AIR TEMP DEG. F
INCHES
MILLIBARS
FT ALTITUDE STD. SI
TEMP. CORRECTION PER DEG. F. ABOVE OR BELOW 75°F
ABOVE 75°F ADD CORRECTION ALGEBRAICALLY, BELOW 75° SUBTRACT
CORRECTION MILLIBARS PER DEG. F
SERIAL NO. 19
INSTRUMENT SCALE MILLIBARS
TL 92460

Figure 6. Barometer ML–102–D (or ML–316/TM), temperature correction curve and conversion chart.

b. Temperature correction. (1) Barometers ML–102–D and ML–316/TM are designed so that the temperature correction at 75° F. is zero. At temperatures above and below this value the indications of the barometer are slightly affected by temperature. However, this correction need not be applied unless it exceeds one-tenth (0.1) millibar,

since the scale of these barometers cannot be read with greater accuracy than that. Ordinarily, for temperatures within 20° of 75° F., the correction will not exceed one-tenth millibar.

(2) A temperature correction curve showing the difference in calibration due to temperature is determined for each instrument individually and is plotted on a graph inside the lid of the case. Figure 6 is an example of such a correction curve.

(3) To correct the observed reading for temperature:

(*a*) Locate the indicated pressure on the horizontal scale of this graph. Note the point on the red correction curve which is vertically above or below this pressure value.

(*b*) Read the value of the correction to be applied per degree Fahrenheit (above or below 75° F.,) from the point on the vertical scale of the graph, corresponding to the point on the red curve.

(*c*) Determine the difference between the existing temperature and 75° F.

(*d*) Multiply the correction (found in b above) by this difference.

(*e*) Add or subtract this value from the observed reading as directed on the calibration chart.

(4) *Example:* Assume that the indicated pressure is 904.3 mb and the temperature is 10° F.

(*a*) Using the reproduction of the chart in figure 6, find the indicated pressure on the horizontal scale. Move up vertically until the pressure line intersects the temperature curve.

(*b*) The correction for this pressure is −0.003 mb per degree F. (The correction is estimated to the nearest 0.001 mb.)

(*c*) A temperature of 10° F. is 65° below 75° F. Therefore, the correction, −0.003, is multiplied by 65, giving a correction of −0.195 mb.

(*d*) Since the reading is taken only to the nearest tenth millibar, the correction becomes −0.2 mb. Therefore, the corrected pressure is

904.3 mb
−.2 mb
904.1 mb

(5) This pressure, as read on the dial of the barometer, when corrected for temperature, is the *station pressure.*

c. Conversion to inches. (1) To convert a reading in millibars to inches of mercury, use the conversion chart inside the lid of the case.

(2) Locate the pressure reading (which has been corrected for temperature) on the conversion chart and simply read off the corresponding value in inches of mercury.

(3) *Example:* For a corrected pressure reading of 904.1 mb, the corresponding pressure in inches of mercury is 26.700 in.

d. Determining approximate differences in elevation. Barometers ML–102–D and ML–316/TM may be used for determining approximate differences in elevation in a manner similar to that used with Barometer ML–102–E. In the following method only one barometer is used. The use of a psychrometer is also necessary, since humidity is a factor to be considered.

(1) Take the pressure reading at the station of lower elevation.

Record the reading, also the time, the temperature, and the humidity.

(2) Take the barometer to the higher elevation. Record the pressure, the time, the temperature and the humidity.

(3) Return the barometer to the original position and take the pressure reading, the time, the temperature and the humidity.

(4) Interpolate between the two sets of readings made at the lower elevation to find the pressure, temperature and humidity values at the lower elevation which corresponds *in time* to the pressure, temperature and humidity values at the higher elevation.

(5) The following is an example of such interpolation:

(*a*) Assume that the pressure reading is taken at the station of lower elevation at 10:30. The pressure is 1015.0 mb; temperature is 100° F.; relative humidity, 62 per cent.

(*b*) Take the barometer to the station of higher elevation. At 11:15 the pressure, corrected for temperature, is 891.3 mb; temperature is 97° F.; relative humidity, 57 per cent.

(*c*) Return the barometer to the original station at 11:45. Pressure, corrected for temperature is 1015.3 mb, temperature is 101° F.; relative humidity, 60 per cent.

(*d*) Tabulating the pressure values:

	10:30	11:15	11:45
Lower station	1015.0 mb	(1015.18 mb)	1015.3 mb
Higher station		981.3 mb	

By interpolation, the pressure at the lower station at 11:15 is 1015.18 mb. Since the reading is taken only to the nearest tenth millibar, this is 1015.2 mb.

(*e*) The influence of temperature and humidity on the values of the correction is sufficiently small that these values need not be known closer than the nearest 2° F. and 10 per cent relative humidity. Thus the average temperature of the two stations is 98° F. and the relative humidity 60 per cent.

(*f*) Using the conversion table, the altitude corresponding to 1015.2 mb is −70 feet. The altitude corresponding to 981.3 mb is 855 feet. Subtracting the values, the approximate difference in elevation is $855-(-70)=925$ feet.

(6) It is now necessary to correct the approximate difference in elevation for temperature and humidity. (As noted in (*e*) above, the average temperature is 98° F., the relative humidity 60 per cent.)

(*a*) Locate 98° F. on the horizontal scale along the bottom of the curves for Air Temp. and Relative Humidity Correction Factor for Altitude (fig. 6). Follow the 98° F. line diagonally upward until it intersects the 60 per cent relative humidity curve. The correction factors are given in the horizontal scale at the top of the curves.

(*b*) Follow the intersection of the 98° F. diagonal and the 60 per cent relative humidity curve vertically upward to this correction factor

scale and read the correction indicated by that scale. This correction is 1.109.

(*c*) Multiplying the approximate difference in elevation by this correction factor (925 x 1.109=1,026), the true difference in elevation is found to be 1,026 feet (fractions of a foot are not considered).

SECTION III

FUNCTIONING OF PARTS

14. PRINCIPLES OF ANEROID BAROMETER. a. General. (1) The aneroid is a form of "elastic" barometer, that is, one in which the elastic deformation of some solid system is used as an indicator of atmospheric pressure.

(2) The aneroid type of barometer can be made extremely sensitive and is convenient to use because of its portability. A further advantage is that its readings are not affected by variation in the force of gravity.

(3) The aneroid barometer is subject to errors due to irregularities in the elasticity of the metal (par. 15) and for this reason it should not be relied upon as an instrument for routine meteorological observations unless compared frequently (at least every 90 days) with a mercury barometer.

b. The Vidie barometer. The type of aneroid most generally used is one invented in 1843 by Lucien Vidie, which uses a wafer-like cell, (sometimes called diaphragm or capsule) of thin, flexible metal, usually brass or German silver, which is very nearly exhausted of air. The opposite sides of the cell are kept apart by a strong internal metal spring; some models use a stiff external spring for this purpose. Usually the elastic properties of the spring determine those of the whole instrument. The residual air in the cell can be adjusted to give a partial correction for temperature. The movement of the cell, caused by variations in pressure, is greatly magnified, and is indicated on a dial by a train of gears and levers.

c. Principle of operation. (1) The barometers treated in this manual differ from the Vidie type in that the material of the cell itself serves as a spring, making the use of an internal or external spring unnecessary. The aneroid element of these barometers consists of one or more cells of beryllium copper which have been almost completely exhausted of air, only enough being left inside to help compensate for changes in the spring properties of the cell as a result of changes in temperature. Corrugations in the cell increase the flexibility of the metal so that there is a greater movement with changes in pressure. Changes in the atmospheric pressure cause the cells to expand and contract. This movement is magnified and transmitted by a lever system connected to a pointer which indicates the pressure values on a dial graduated in inches of mercury or the equivalent pressure value in millibars.

(2) A detailed description of the different models of the barometer covered by this manual, with the functioning of the aneroid mechanisms, is given in paragraphs 16, 17, and 18.

15. ERRORS OF ANEROID BAROMETER. Factors which introduce errors into the readings of the aneroid barometer are *hysteresis, temperature, scale errors,* and *drift.*

a. Hysteresis. (1) One of the chief causes of error in an aneroid barometer is hysteresis. All elastic materials tend to change shape when

placed under stress. As soon as the stress is removed, they return *almost* to their original shape. The retardation or failure of the material to assume *completely* its original form is known as hysteresis. All aneroid barometers are subject to the effects of hysteresis although an attempt is made to keep these effects to a minimum by the proper selection and treatment of materials. Over a long period of time hysteresis effects gradually tend to disappear.

(2) Hysteresis occurs in the pressure sensitive cell of the aneroid barometer and for that reason appreciable errors may be noticeable immediately after a large and rapid pressure change. These errors can be greatly reduced by waiting a sufficient length of time before taking a reading. It is difficult to make a specific recommendation as to the interval of time necessary to reduce hysteresis errors to a minimum since hysteresis varies with the amount of change in pressure, with the rate of change, and with the time involved – that is, the length of time at which the barometer has been subjected to a pressure differing from current atmospheric values.

(3) For pressure changes occurring at any fixed station, hysteresis errors are small enough to be neglected. When the barometer is subjected to a comparatively large pressure change for a short time only, and then restored to its previous values, hysteresis effects are small and quickly disappear. Hysteresis errors are probably most pronounced when a barometer is transported by airplane, especially if the flight is of several hours duration and the plane flies at high altitude. Therefore, to be reasonably sure of reducing hysteresis errors to a minimum under such circumstances, it is advisable to wait at least 24 hours before taking a reading.

b. Temperature. A second and exceedingly important error which affects the aneroid is temperature changes. Without compensation for changes in temperature the errors of an aneroid would be quite large. Several methods of temperature compensation are used in the barometers covered by this manual.

(1) *Aneroid cell.* If a barometer is maintained at a constant pressure, a change in temperature, if not compensated, will cause a movement of the pointer on the dial. This indicated change in pressure is due to a physical change in the dimensions of the instrument and also to variations in the stiffness of the pressure sensitive cell. This latter condition may be compensated, for the most part, by leaving a small amount of air in the cell. Thus when a change in temperature occurs, the change in pressure of the air inside the cell partially balances the change in strength of the metal. This does not entirely compensate for changes in temperature. Therefore, temperature correction curves are provided for some models of Barometer ML–102–(*) and ML–316/TM. These corrections, however, are small, indicating that the greater part of the error has been compensated.

(2) *Bimetal temperature compensation shaft.* Barometers ML–102–B, ML–102–E, and ML–102–F use an additional temperature compensation in the form of a bimetal pivot shaft made of a strip of invar and a strip of brass welded together lengthwise. Since invar and brass have different coefficients of expansion, changes in temperature cause the bimetal shaft to bow slightly, thus changing the indication of the pointer.

(3) *Temperature correction chart.* Barometers ML–102–D, ML–102–E, and ML–316/TM have a temperature correction plotted for each instrument individually. Specific instructions for the application of temperature corrections to Barometer ML–102–E are given in paragraph 11. Specific instructions for the use of the temperature curve for Barometer ML–102–D or ML–316/TM are given in paragraph 13b.

c. Scale errors. (1) The dials of Barometers ML–102–B, ML–102–E, and ML–102–F have linear graduations; that is, the spacing between each of the 0.02 inch graduation lines is the same. The aneroid cells used in these barometers do not expand and contract linearly with changes in pressure, but by selection of cells and individual adjustment of the lever system the movement of the *indicating pointer* may be made approximately linear with changes in pressure. There is always some residual scale error, however, which varies slightly at different parts of the scale. Small differences in the characteristics of individual aneroid cells cause variations in the value of this scale error among different barometers. It is necessary, therefore, to calibrate barometers individually to eliminate scale error.

(2) Barometer ML–102–E has been calibrated for scale error and the corrections are included in the temperature correction curves fastened to the back of each barometer (fig. 5). Thus no separate correction can be applied for scale error; it is automatically included when temperature corrections are made.

(3) Barometers ML–102–B and ML–102–F do not have either temperature or scale error correction curves, hence pressure measurements made with either of these instruments probably are less accurate than those made with Barometer ML–102–E, ML–102–D, or ML–316/TM. The error in indication introduced by neglecting scale and temperature corrections will vary among instruments and at different pressures. On the average, this error probably does not exceed 0.7 millibar.

(4) The dials of Barometers ML–102–D and ML–316/TM are individually calibrated for each instrument. This reduces scale error to an amount which need not be considered in making pressure measurements.

d. Drift. (1) Another error to which the barometer is subject is drift (often called *creep*), which is due to changes in the aneroid cell occurring slowly over a long period of time. Drift is caused by molecular changes in the metals of which the cell is made, and by alterations in the shape of the cell, due to the tendency of all materials to assume a new permanent shape when placed under steady stress. In meteorological textbooks, drift is sometimes referred to as "secular change," for it is an error taking place over a long period of time.

(2) Drift is manifest by a gradual increase in the difference between the indications of the aneroid barometer and a mercurial barometer with which it may be compared. Errors of drift can be largely eliminated by setting the barometer to indicate the pressure shown by an accurate mercury barometer.

(3) Some barometers drift because of very minute leaks in the evacuated cell. Usually a leaking cell is detected before the instrument leaves the manufacturer's plant, but occasionally a leak can develop in a barometer that has been in use some time. The indications of a leak are progressively lower readings than are normal for

the station. There is no way to remedy the defect. Return the barometer to the depot and requisition a new one.

(4) For the first few months after the aneroid is built, the drift effects are more pronounced, but after this time they usually become negligible. In general, the longer the barometer is in use, the more consistent the performance is likely to be.

(5) Occasionally a barometer will show a persistent drift. To detect this condition, keep a record of the amount of *resetting* necessary to eliminate drift. If, over a period of time, this *total* exceeds 12 millibars, requisition a new barometer and return the defective instrument to the depot.

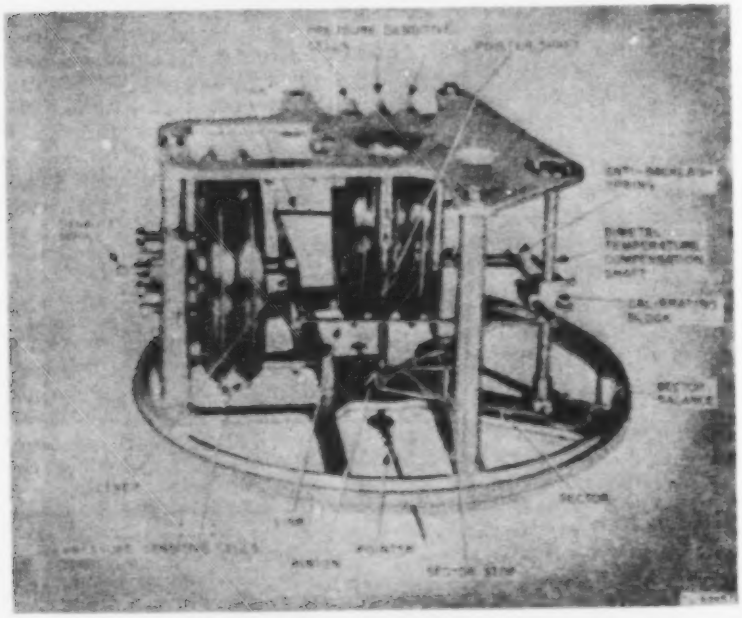

Figure 7. Barometer ML–102–B, aneroid mechanism.

16. BAROMETER ML–102–B (fig. 7). **a.** The mechanism of Barometer ML–102–B is built within a brass frame. While differing considerably in internal appearance, this barometer functions practically the same as Barometers ML–102–E and ML–102–F, except for an additional step in magnification.

b. In Barometer ML–102–B the atmospheric pressure acts upon *two* sets of cells. The movement of one group (of two cells) is transmitted to the *center* of the main lever. The movement of the other group (of three cells) is transmitted to one *end* of the main lever. Thus the initial magnification is performed by a simple lever in which one end and the center are moved oppositely by the two sets of cells. This causes a greatly magnified movement of the free end of the lever. The com-

bined motion resulting from the movement of both sets of cells is transmitted to the bimetal shaft from the free end of the main lever by means of an adjustable link. From this point, the functioning of the parts is identical to that of Barometers ML–102–E and ML–102–F.

c. This model utilizes a coil spring concentric with the pointer shaft to take up backlash in the gear teeth instead of the flat hairspring used in the other models.

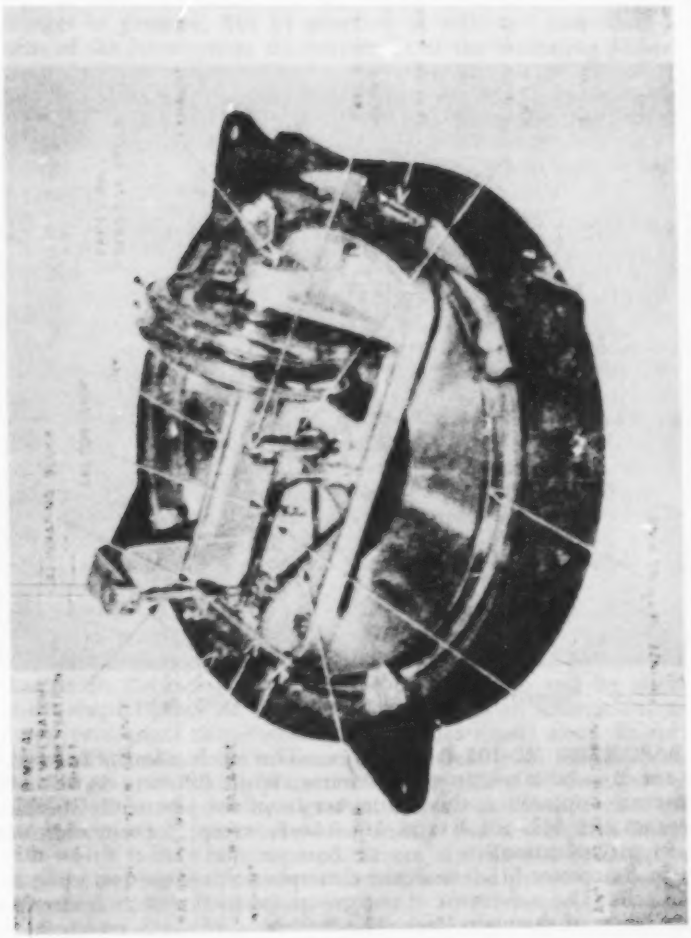

Figure 8. Barometer ML–102–E (or ML–102–F), aneroid mechanism.

17. BAROMETERS ML–102–E and ML–102–F (fig. 8). **a. Mechanism.** (1) The mechanism of Barometers ML–102–E and ML–102–F is mounted below the dial and is built upon a brass casting which is

screwed to a bronze gear plate. The gear plate is fastened inside the top of the barometer case by brackets and screws.

(2) The aneroid element consists of two pressure sensitive cells approximately 2¼ inches in diameter. The cells have been almost completely evacuated (about 95 per cent) through a tube which is pinched off and soldered at the end.

(3) Changes in the atmospheric pressure cause the cells to expand and contract, and this motion is transmitted by a connecting link to an adjustable lever mounted on a bimetal temperature compensation shaft. The link is connected at one end to the aneroid cells and at the other to the adjustable lever by small pivots and is held in place by antifriction washers and locking springs. The adjustable lever converts the motion of the link into a rotation of the bimetal temperature compensation shaft. A small calibrating block near the center of the bimetal shaft serves as the mounting for the adjustable lever. A counterbalance rod with a counterbalance weight at the end also is attached to the calibrating block. The purpose of this balance weight is to balance the linkage system so that the pointer will not change in indication when the position of the barometer is changed. A fine coil spring, 1¼ inches long, is attached at one end to a rod on the calibrating block and anchored at the other to the casting. Its purpose is to prevent backlash by keeping the linkage system under tension.

Note. Both Barometers ML–102–E and ML–103–F are calibrated for a vertical position and should be used in that position for accurate readings.

(4) The bimetal temperature compensation shaft is made of a strip of brass and a strip of invar welded together lengthwise. It is set in jeweled bearings at the top and bottom. Since the coefficient of expansion of invar is much less than that of brass, changes in temperature cause the shaft to bow slightly. The bowing of the shaft displaces the adjustable lever which is mounted near the center of the shaft, and thereby changes the indication of the pointer slightly. This change in indication offsets the change resulting from slight movement of the pressure sensitive cells caused by variations in temperature.

(5) A brass sector is fastened to the bimetal shaft by a hub containing two setscrews. This sector transmits the motion of the bimetal shaft to the pointer shaft. Fine gear teeth cut into the arc of the sector mesh with a small pinion on the pointer shaft. At the opposite end of the sector is a counterweight to balance the sector on the shaft. A U-shaped stop is mounted on the casting to limit the movement of the sector.

(6) The pointer shaft is set in jeweled bearings. The pointer, which fits over the end of the pointer shaft, is made of aluminum, painted dull black, and has a counterweight on the non-indicating end. The indicating end, which projects over the scales on the dial, is approximately 0.011 inch wide.

(7) A hairspring is attached to the pointer shaft on the forward side of the casting, immediately below the dial. Its purpose is to take up any backlash between the sector and the pinion of the pointer shaft.

(8) A horseshoe-shaped brass stop is fastened to the brass casting to prevent expansion of the pressure element to a point below the lower pressure limit of the instrument. This could happen only when the instrument is transported by air.

(9) Teeth, cut around the periphery of the gear plate, mesh with a worm which rotates the mechanism and the pointer so that the aneroid

may be set to read current atmospheric pressure. The shaft of the worm extends outside the barometer case and may be adjusted by means of a screwdriver.

b. **Magnification.** (1) A movement of 0.009 inch (linear measurement) of the aneroid cells causes the pointer to move over a pressure interval of 1 inch. When it is remembered that an ordinary human hair is 0.003 inch in thickness, the sensitivity of the instrument and the extent of the magnification of the cell movement may be realized.

(2) In the first stage, the ratio of magnification is the radius of the sector as compared with the distance from the end of the adjustable lever to the bimetallic shaft.

(3) In the second stage, the ratio of magnification is the radius of the sector as compared with the radius of the pinion gear.

(4) The third stage of magnification is the ratio of the radius of the pointer from the pointer pivot shaft to the scale being used on the dial to the radius of the pinion gear. Thus the outer scale, the inch scale, givse slightly greater magnification than the inner millibar scales

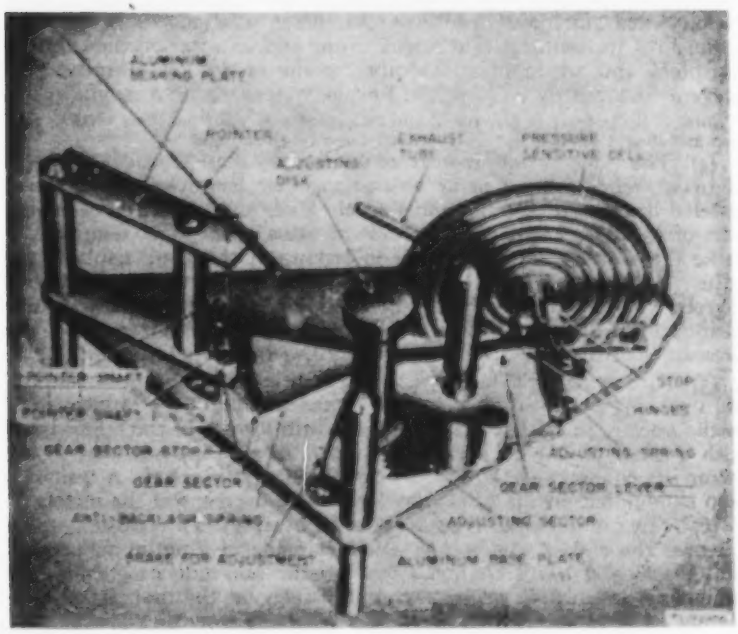

Figure 9. Barometer ML-102-D (or ML-316/TM), aneroid mechanism.

18. BAROMETERS ML-102-D and ML-316/TM (fig. 9). **a. Mechanism.** (1) The mechanism of Barometers ML-102-D and ML-316/TM is built upon a triangular-shaped aluminum base plate. The difference in range of the two instruments is achieved by changing the spring rate of the pressure sensitive cell. The aneroid element is a single corrugated cell of beryllium copper about 2 inches in diameter and

1/8 inch in thickness. The lead exhaust tube through which the cell is evacuated is pinched off and sealed at the end.

(2) The movement of the cell, caused by the varying pressure of the atmosphere, is transmitted to the gear sector lever by thin strips of beryllium copper which act as hinges. A fixed hinge serves as the fulcrum of the gear sector lever. The teeth of the gear sector engage a small pinion on the pointer shaft. A wire safety stop prevents the teeth on the gear sector from becoming disengaged from the pinion gear during severe vibrations or rough handling. A small auxiliary coil spring is attached to the gear sector lever. The tension of the spring can be varied by an adjusting disk which has a gear at its lower end which meshes with a brass adjusting sector (fig. 9). The adjusting disk is reached through a plugged opening in the plastic window. The range of adjustment is approximately 10 millibars. Backlash in the gears is removed by means of a small wire spring attached to the lower side of the gear sector. The tension of this spring is transmitted to the pointer shaft by a nylon thread looped once around a small lucite drum at the base of the pointer shaft. A stop is provided to prevent expansion of the cell below its lower limit during air transportation.

(3) The pinion is fastened to the pointer shaft which revolves in a jeweled bearing at the bottom and extends through a hole in the top bearing plate. The pointer, fastened to the end of the shaft, is made of three sections of fine aluminum tubing and is clamped to the shaft by a small setscrew.

b. Magnification. Magnification of the cell movement is accomplished in three stages:

(1) The first stage is a simple lever magnification, being the ratio of the distance between the fixed hinge (which acts as the fulcrum of the lever) and the teeth of the gear sector to the distance between the two hinges.

(2) The second stage is the ratio of the diameter of the gear sector to the diameter of the pinion.

(3) The third stage is the ratio of the distance between the pointer shaft and the scale being read to the radius of the pinion.

SECTION IV

MAINTENANCE

Note. Failure or unsatisfactory performance of equipment will be reported on WD, AGO Form 468. If this form is not available, see TM 38-250.

19. CARE OF BAROMETER. a. General. (1) Protect the aneroid against violent and sudden jolts.

(2) Use care in handling and transporting.

(3) Do not move the instrument unnecessarily.

b. Plastic window. (1) Clean the plastic window that protects the dial by wiping with a damp cloth and polishing with a soft clean cloth. Do not use soiled or gritty cloths. An occasional thin coat of wax well rubbed with a soft clean cloth will help remove any existing scratches and at the same time provide a protective film to prevent further scratching.

(2) If the plastic window becomes wavy when exposed to a combination of high temperature and high humidity, requisition a new one.

20. FIELD INSPECTION AND MAINTENANCE. a. Accuracy tolerances. Barometers ML-102-(*) are precision instruments whose readings are generally dependable to 0.7 millibar (0.02 inch of pressure) or better. Barometer ML-316T/M is usually dependable to one millibar (0.03 inch of pressure) or better. The readings made with these instruments ordinarily will be considerably more accurate than these tolerances, provided the barometers are compared periodically with a mercury barometer (see b below), checked for free, unimpeded action of the linkage system (see c below), and reset to agree with a mercury barometer (par. 21).

b. Comparison with mercury barometer. (1) To check the accuracy of the aneroid, compare it with a mercury barometer of known accuracy at least once every three months, or at any time the instrument is dropped, mishandled, or subjected to severe vibrations in transportation. The indications of the aneroid will be more reliable if this check is made at or near the average pressure of the station where the aneroid is used.

(2) Hang or set the aneroid barometer at the same level as the cistern of the mercury barometer.

(*a*) Barometer ML-102-B, ML-102-E, or ML-102-F, must be hung alongside the mercurial barometer with the dial in a vertical position.

(*b*) Barometer ML-102-D or ML-316/TM should always be placed with the dial in a horizontal position.

(3) Read the mercury barometer and apply temperature, gravity, and instrumental corrections to determine the true station pressure.

Note. In comparing an aneroid instrument supplied with a millibar scale only against a standard mercury barometer which is graduated in inches only, convert the readings of the aneroid into inches of mercury rather than convert the readings of the mercury barometer into millibars. (One millibar equals 0.02954 inches.)

(4) The difference between the true station pressure and the indication of the aneroid is the error of the aneroid barometer. If this error exceeds 3 millibars, it is probable that the mechanism has sustained

some permanent damage and a new barometer should be requisitioned.

c. Testing linkage. The linkage system of an aneroid barometer must be as friction-free as possible if the barometer is to respond to small changes in pressure. Anything which increases this friction decreases the sensitivity of the instrument very rapidly. In regions of prevailing high humidity the tests given in (1), (2), and (3) below, should be made at least twice a month. In other regions, monthly tests should be sufficient.

(1) *Tests for all models.* The simplest test for the proper functioning of the linkage system is to note the change in indication of the aneroid when its elevation is changed approximately 15 feet.

(*a*) Read the barometer very carefully at the lower elevation.

(*b*) Holding the barometer steadily in both hands and being careful not to jar or move it suddenly, walk upstairs, or otherwise change its elevation approximately 15 feet. The pointer should indicate the changed elevation by a decrease in pressure as the elevation is increased.

(*c*) Now return the barometer to the original elevation and again take the reading. The pointer should have returned to its original position.

(2) *Amount of change.* Generally, there will be a change of approximately one-tenth millibar for every 3 feet of change in elevation. Any barometer that does not respond to a change of 15 feet in elevation is probably defective and should be returned to the depot.

(3) *Barometers ML–102–D and ML–316/TM.* (*a*) These models are more sensitive than other types to slight changes of pressure. A change in elevation of as little as 3 feet should cause a slightly different indication of the pointer. This is sometimes hard to discern and the least vibration will destroy the value of this test.

(*b*) Another and easier test for these models consists of the following: Pick up the barometer case in both hands. With the thumbs in the center of the plastic window, suddenly press inward a slight amount. If the barometer is functioning properly, the pointer will quickly move a small amount to indicate a higher pressure, then as quickly return to its original position. Remove the thumbs suddenly. The pointer should move slightly in the opposite direction to indicate a decrease in pressure and then quickly return to its original position.

Warning: *Never open the case of Barometers ML–102–B, ML–102–E, or ML–102–F. Any adjustment that can be made in the field can be made without opening the case. Barometer ML–102–D and ML–316/TM may be opened to place the mechanism in a new case or to make adjustments in an emergency, as outlined in paragraph 23. Except for these adjustments, the case must not be opened. These barometers are precision instruments. Tampering with the internal mechanism or attempting to adjust the linkage or magnification system will make it necessary to recalibrate the instrument. This CANNOT be done by Signal Corps repair facilities. Recalibration involves the use of specialized auxiliary precision equipment and highly skilled personnel available only at the manufacturer's plant. The adjustments and replacements which are allowed on these barometers are given in the following paragraphs. Using personnel are instructed to confine themselves to these operations.*

21. ADJUSTING BAROMETER. a. Comparative readings. (1) Before adjusting the aneroid barometer, make at least six comparative readings with an accurate mercury barometer. These readings should be made at intervals during a period of 1½ to 2 hours. If time permits, even more readings should be made since the greater the number of such comparative readings, the higher the degree of accuracy in the final results. Take the average of the readings of each barometer.

(2) Subtract the *average* of the aneroid readings from the *average* of the mercury readings. If the average reading of the aneroid exceeds that of the mercury barometer, the difference should have a negative sign.

(3) If the difference exceeds 0.3 millibar (0.01 inch) adjust the aneroid by the amount of the difference (see b below).

(*a*) If the difference has a positive value, the reading of the aneroid should be increased.

(*b*) If the difference is negative, the aneroid reading should be decreased.

Note. It is doubtful whether improved accuracy can be obtained by making an adjustment of less than 0.3 millibar since the random error of the instrument is probably as much as 0.3 millibar.

b. Adjusting Barometers ML-102-B, ML-102-E, and ML-102-F. (1) Insert a screw driver in the slot which turns the worm of the gear plate (fig. 10). Rotate the gear plate by means of this worm until the pressure indicated by the aneroid has been changed by the amount of the average difference as determined in a above.

(2) Turn the screw clockwise to decrease, and counterclockwise to increase the indicated pressure.

c. Adjusting Barometers ML-102-D and ML-316/TM. (1) Remove the plastic screw-plug from the plastic dial cover.

(2) Insert a small-bladed screw driver in the slot of the adjusting disk. A clockwise rotation of this disk causes a like movement of the pointer. This adjustment is limited to one-half revolution of the disk either side of the index line marked on the face of the dial (fig. 3) or

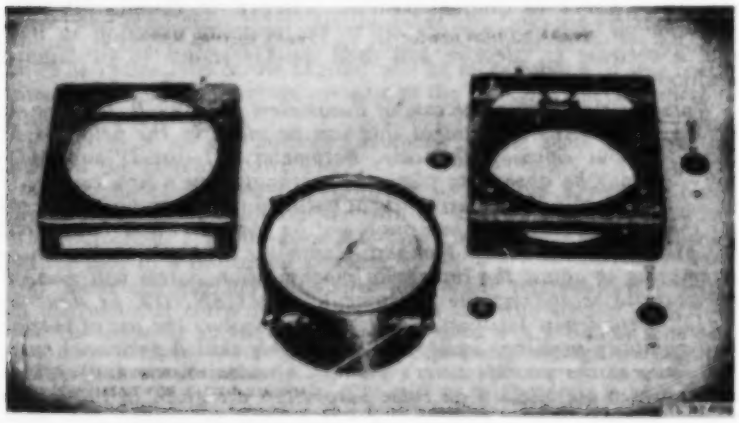

Figure 10. Barometer ML-102-F (ML-102-B or ML-102-E), disassembly of frame.

approximately 10 millibars. The barometers can readily be adjusted by the use of this disk.

22. REPAIRS TO BAROMETERS ML-102-B, ML-102-E, and ML-102-F.

a. Replacing hanger. (1) It is necessary to remove the barometer case from the metal frame to attach a new hanger (fig. 10). First remove the four small screws in the sides of the frame and remove the upper part of the frame.

(2) Remove the nuts, star lockwasher, sleeves, and large round washers securing the barometer to the shockmounts at each of the four corners of the frame. Remove the case from the frame.

(3) With a short screw driver, remove the two screws that hold the hanger posts to the frame.

(4) Insert one new post and tighten the screw.

(5) Insert the hanger in the two posts and tighten the screw of the other post.

Note. On Barometer ML-102-E the posts of the hanger are attached to the frame by means of nuts and washers instead of screws. In this case, use a pair of fine-nose pliers to remove the posts.

(6) Reassemble the frame (fig. 10 shows the order in which these parts are assembled).

b. Replacing plastic window. It is necessary to remove the upper half of the frame to replace the plastic cover which protects the dial.

(1) Follow directions in a (1) above to disassemble the frame.

(2) Start at one end and gently pry up the snap ring with a screw driver. Remove the ring and the plastic window.

(3) Make certain the new window is washed, polished, and free from fingerprints. Insert the new window and replace the snap ring.

(4) Reassemble the frame (fig. 10).

c. Replacing pointer. The pointer of these barometers may be loosened on its shaft by severe vibration. When this occurs, proceed as follows:

(1) Follow the direction given in a and b above for removing the upper half of the barometer frame and the plastic window.

(2) Place the pointer on its shaft lightly and set it to read the station pressure. Place the thumb nails on the pointer on opposite sides of the pointer shaft, but as close to the shaft as possible. Press directly downward on the pointer until it is firmly set on the shaft. *Be very careful not to bend the shaft.*

(3) Reassemble the dial cover and frame.

23. REPAIRS TO BAROMETERS ML-102-D and ML-316/TM. a. Replacing plastic window. (1) Open the cover, press the spring stop by the right-hand hinge, and remove the cover.

(2) Remove the four screws and washers that hold the plastic panel in place.

(3) Gently pry up the plastic dial cover with a pen knife or a screw driver and lift out the panel.

(4) Insert the new window, being sure it is polished and free from fingerprints. The plastic screw in the cover must be directly above the adjusting disk (fig. 3).

(5) Replace and tighten the screws and washers.

b. Replacing pointer.

Caution: *This is a very delicate operation. It must be attempted in the field only when absolutely necessary and only by competent personnel.*

(1) Remove the cover and plastic window as described in a (1) to (3) above.

(2) Using a very small screw driver or the blade of a pen knife, loosen the pointer clamping screw and remove the pointer, being careful not to bend the pointer shaft.

(3) Carefully place a new pointer on the pointer shaft and rotate it around the shaft until it reads the pressure (at least within a half millibar) as determined by a mercury barometer. Gently press the pointer down flush with the end of the pointer shaft.

(4) Tighten the pointer setscrew, again being careful not to bend the pointer shaft.

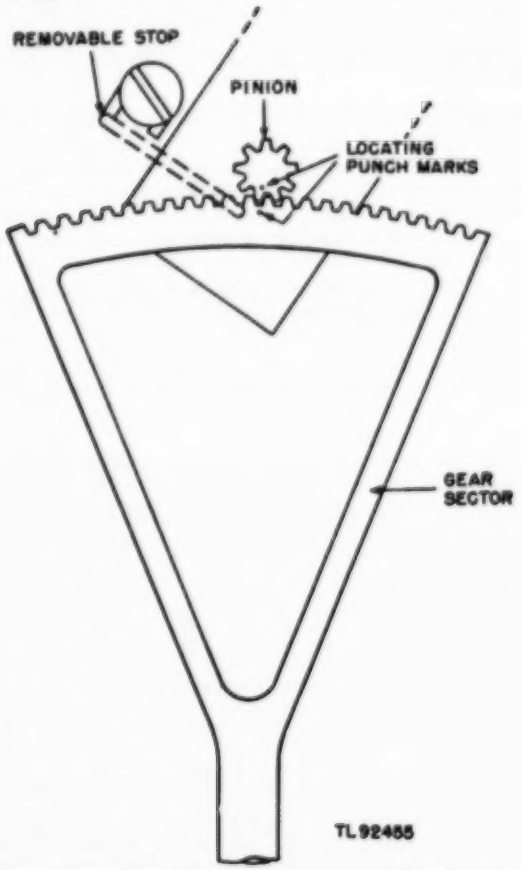

Figure 11. Barometer ML-102-D (or ML-316/TM), adjustment of gear sector and pinion.

(5) Use the adjusting disk on the dial to set the aneroid to the *exact* station pressure. This disk should not be used for large adjustments.

(6) The tip of the pointer should clear the dial by at least 1/16 inch. If it does not, *very carefully* spring the pointer upward until this clearance is obtained.

(7) Replace the plastic window, screws, washers, and cover.

c. Placing mechanism in new case.

Note. The mechanisms and dials of Barometers ML-102-D and ML-916/TM are not interchangeable, since each aneroid mechanism is hand-calibrated with its particular dial, but the complete mechanism, with dial, may be placed in a new case. Before placing in a new case, however, check the instrument against an accurate mercury barometer and apply the linkage test (par. 20c (3)), to make sure the interior mechanism is functioning properly. A barometer that is in error by 5 millibars, or more, should be replaced. Ordinarily anything that would damage the case sufficiently to require it to be replaced would also damage the mechanism. If the case is replaced in the field, it must be done only by qualified personnel.

(1) Remove the cover and plastic window according to instructions above.

(2) By means of the rubber mounts in the two rear corners, carefully lift the dial and mechanism assembly from the case. Be extremely careful not to damage the corrugated cell and the pointer during this operation.

(3) Holding the dial and mechanism assembly by the rear rubber mounts, fit the two front rubber mounts into the front corners of the new case. (Avoid striking the cell against the metal stop in the front righthand corner.) Now ease the dial to a level position, being sure the rubber mounts are resting against the stops in the four corners.

(4) Replace the plastic window, screws, washers, and cover.

d. Adjusting rack and pinion (fig. 11).

Caution: Occasionally, following a severe shock, the barometer may show an error of 10 millibars. This may indicate that the rack and pinion have jumped a tooth. In this event, send the barometer to the Signal Corps depot where it will be adjusted by qualified personnel. *Do not attempt this adjustment in the field!*

(1) The distance between teeth is equal to 10 millibars on the scale. Look closely and note that there are three prick punch marks on the rack between the teeth. There is also one prick punch mark on one of the teeth of the pinion (fig. 11).

(2) The distance between two punch marks on the rack is equal to one complete revolution of the pinion. When the teeth are properly meshed, the punch mark on the pinion should be directly opposite one of the punch marks on the rack as shown in figure 11.

(3) If the punch mark on the pinion is out of mesh with the punch mark on the rack, swing the vertical stop (fig. 11) away from the rack 90° to the right or left, with the aid of a small pair of pliers. Gently raise the rack above the pinion and rotate the pinion until the punch marks line up. Allow the rack to return to its normal position and replace the stop in its original position.

24. LUBRICATION. The mechanism of Barometer ML-102-(*) does not require oil. Oil would only interfere with the proper functioning of the instrument and thereby introduce serious errors in reading. DO NOT USE OIL ON THE MECHANISM!

SECTION V

SUPPLEMENTARY DATA

25. MAINTENANCE PARTS LIST FOR BAROMETERS ML-102-B, ML-102-E AND ML-102-F.

Ref. figure	Signal Corps stock No.	Name of part and description	Quan. per unit	Depot stock	Station stock	Region stock
1	7A470	CASE, barometer carrying: empty; Friez #V-500634; (part of Barometer ML-102-E).	1	•		•
10	7A312E/C1	CASE, barometer housing: empty; Friez #AS-500537; (part of Barometer ML-102-E).	1	•		•
10	6L20806-8.10	SCREW, machine: brass; RH; 6-32 thd; NF; Friez #A-500528; (part of Barometer ML-102-E).	1	•		•
10	7A316/H1	HANGER: brass; pentagon-shaped; 2 shoulders 5/8" long; Friez #A-500439; (part of Barometer ML-102-E).	1	•		•
1	7A471	CASE, barometer carrying: empty; Friez #S-40125; (part of Barometer ML-102-B, ML-102-F).	1	•		•
10	7A312B/C1	CASE, barometer housing: empty; Friez #P-38038; (part of Barometer ML-102-B, ML-102-F).	1	•		•
10	6L6632-6.7B	SCREW, machine: brass; FH; Friez 500235-P2; 6-32 thd; NF; (part of Barometer ML-102-B, ML-102-F).	1	•		•
10	7A316/P1	POST: hanger; brass; Friez #38041; (part of Barometer ML-102-B, ML-102-F).	1	•		•
10	7A312B/W1	WINDOW: clear lucite or equal; Friez #X-38044; (part of Barometer ML-102-B, ML-102-E, ML-102-F).	1	•		•
10	7A316/H1	HANGER: brass; pentagon-shaped; 2 shoulders 1/4" long; Friez #39492; (part of Barometer ML-102-B, ML-102-F).	1	•		•

*Indicates stock available.

26. MAINTENANCE PARTS LIST FOR BAROMETERS ML-102-D and ML-316/TM.

Ref. figure	Signal Corps stock No.	Name of part and description	Quan. per unit	Depot stock	Station stock	Region stock
1	7A312D/C2	CASE: carrying, barometer; empty; Wallace and Tiernan No. FU-1955.	1	*		*
1	7A312D/C1	CASE: housing, barometer; empty; Wallace and Tiernan No. FU-1943.	1	*		*
3	7A312D/W1	WINDOW: clear lucite; Wallace and Tiernan No. FP-4053.	1	*		*
3	7A312D/P1	POINTER: Wallace and Tiernan No. FU-1877.	1	*		*

*Indicates stock available.

U.S. GOVERNMENT PRINTING OFFICE: 1960 O-582 912 39269

PIN : 015867-000